APPENDIX K
TRACTION SAND ASSESSMENT FOR THE ST. REGIS RIVER TMDL

Prepared by Land and Water Consulting, Inc.

Introduction

Main sources of sediment in the St. Regis River are thought to be traction sand application, contribution from cut and fill slopes, and an extensive forest road network. Delivery of sediment from these non-point sources was analyzed through aerial photograph assessment, cut and fill slope measurements, and in-stream indicators. This report focuses upon the delivery of traction sand from Interstate 90 into the St. Regis River. Mechanisms for traction sand delivery into the St. Regis River include direct casting, fill slope transport, and culvert transport. The movement of traction sand along roadside ditches at the base of cut slopes was also examined along with cut slope erosion. In addition, this report includes an analysis of sediment delivery at several tributary crossings located on non-National Forest lands.

Methods

Traction Sand Assessment

The input, storage, and transport of traction sand were examined along the St. Regis River. Data pertaining to the annual application of traction sand along Interstate 90 between St. Regis and Lookout Pass was obtained from the Montana Department of Transportation. The storage and transport of traction sand were assessed based on the proximity of the interstate to the stream channel and the movement of traction sand on interstate fill slopes. The routing of traction sand through culverts, as well as the input of traction sand from bridge decks, was also estimated.

Interstate 90 was delineated based on the proximity of the road to the stream channel using the 1996 orthophoto quads. Interstate stationing begins at the overpass just east of the Montana-Idaho border and progresses in 0.1-mile increments eastward. Sections were classified as within 100 feet, 200 feet, 300 feet, and greater than 300 feet of the stream channel using GIS software. Measurements were made from the edge of the road shoulder to approximately the center of the stream channel. Thus, distances are generally over-estimated. Sites in which the road is within 100 feet of the stream channel were further classified as between 50 and 100 feet, 25 and 50 feet, and less than 25 feet using results obtained during the shade assessment conducted using aerial photographs along with observations made during field work.

Interstate 90 fill slopes were investigated at cross sections perpendicular to the road at 13 sites between Lookout Pass and Saltese and several intermittent sites between Saltese and St. Regis. These measurements were made to determine traction sand accumulation and transport, though they are not directly related to the mean annual application rate, since traction sand deposits can accumulate over several years. Fill slopes were situated primarily along the eastbound lane of Interstate 90 in this area. The depth of traction sand deposits on fill slopes was measured at five-foot intervals progressing away from the road shoulder. Every five feet a standard shovel, with 0.16-foot (5 cm) delineations drawn on the blade beginning at the tip, was placed into the fill

slope perpendicular to the angle of the slope and pressed down once firmly with the boot sole. This was repeated every five feet until no traction sand was observed. Many of the traction sand deposits were extremely compacted and difficult to dig into; especially those near the road shoulder and on lower angled slopes. Thus, field measurements tended to under-estimate the depth of traction sand in these locations. The angle of the fill slope was measured with a hand-held clinometer.

Culverts were first identified using the "as constructed" highway plans along with the 1996 orthophoto quads. Overall, 184 culverts were identified prior to field work along 33.4 miles of Interstate 90, of which 66 culverts potentially drain into the stream channel. Thirty-nine of the 66 culverts that potentially drain into the stream channel are located at the base of cut slopes. Culverts potentially draining into the stream channel were located in the field, contributing cut slope road length was determined, and delivery to the stream channel was assessed.

Interstate 90 cut slopes drained by culverts were assessed for delivery of cut slope material into the stream channel. Cut slopes were located primarily along the westbound lane of Interstate 90. The horizontal length of cut slopes was measured on the 1996 orthophoto quads with 0.1-mile stationing. The cut slope "face" was measured in the field using Leica LRF 800 Rangemaster binoculars while standing at the base of the cut slope and measuring the distance to the top. This was repeated at several points along each cut slope and an average height was used to determine the area of cut slopes. Cut slope material was visually assessed for erodibility and the amount of surface area covered with bedrock, boulder, cobble, gravel, and sand was determined. Cut slopes identified as potentially draining into the stream channel were walked along their entire length. Cut slopes lacking any culverts draining into the stream channel were considered to not deliver sediment into the stream channel from the abutting lane of interstate.

Stream Crossings

Sediment contribution was assessed from several stream crossings on non-Forest Service lands. The total number of stream crossings on private land was tallied using GIS. A subset of stream crossings was then assessed in the field. Assessed stream crossings were all located in the lower portions of a given tributaries watershed. For each stream crossing the contributing length of road, the tread width, base erosion rate, gravel factor, percent cover, and percent delivery were determined (Washington Forest Practices Manual 1997). A base erosion rate of 30 tons/acre/year was used in this analysis (Washington Forest Practices Manual 1997).

Results and Discussion

Annual Traction Sand Application Rates

Six years of data (1997-2002) from the Montana Department of Transportation indicate that an average of 16,398 cubic yards of traction sand are applied over a winter season to Interstate 90 along 33.4 miles extending from mile marker 0 at the Montana-Idaho border at the top of Lookout Pass to mile marker 33.4 at St. Regis (**Table K-1**). Application of traction sand varied from 10,383 cubic yards to 22,460 cubic yards (measured over the fiscal year, which extends from July 1 through June 30). One cubic yard of slightly damp sand weighs 2,850 pounds (D. Scheck, MDT, pers. comm., 2003). Thus, an average of 23,367 tons of traction sand is applied annually, with a minimum of 14,796 tons a maximum of 32,006 tons. One hundred percent of

the traction sand particles applied to Interstate 90 along the St. Regis River pass through a 3/8-inch sieve (9.5 mm), 40 to 80% pass through a #4 mesh (0.187 inches, 4.75 mm), 0 to 40% pass through a #40 mesh (0.0165 inches, 0.425 mm), and 0 to 10% pass through a # 200 mesh (0.0029 inches, 0.075 mm) (E. Stimson, MDT, pers. comm., 2003).

Table K-1. Amount of traction sand applied to 33.4 miles of Interstate 90 over six winter seasons between the top of Lookout Pass and St. Regis, Montana (MDT 2003)

Year	Cubic Yards	Tons
1996-1997	20,427	29,108
1997-1998	10,383	14,769
1998-1999	17,120	24,396
1999-2000	15,495	22,080
2000-2001	12,505	17,820
2001-2002	22,460	32,006
2002-2003	10,390	14,806
2003-2004	16,265	23,178
2004-2005	10,926	15,570
2005-2006	17,642	25,140
2006-2007	14,517	20,687
Mean Annual Rate	**15,285**	**21,778**

In the 2001-2002 winter season, 61% of the traction sand was applied between mile marker 0 and mile marker 10, which is located near the Saltese exit, 18% of the traction sand was applied between mile marker 10 and mile marker 22, which is located near the Twelvemile Creek exit, while the remaining 21% of traction sand was applied between mile marker 22 and mile marker 34, which is near the St. Regis exit (D. Moeller, MDT, pers. comm., 2003). These sections contain 10 miles, 12 miles, and 12 miles of road length respectively. For the purposes of this study the 10 miles between Lookout Pass and Saltese will be considered to receive 60% of the traction sand applied annually, while application rates of 20% will be assumed for the other two sections.

The 60-20-20 percentages were applied to the average annual rate of traction sand application. There are an estimated 9,171 cubic yards of traction sand applied annually between Lookout Pass and Saltese, while 3,057 cubic yards are applied annually to the other two sections (**Table K-2**). It's estimated that 13,067 tons of traction sand are applied annually between Lookout Pass and Saltese, while 3,057 tons are applied to both of the downstream sections. Assuming an average lane width of 12 feet across four lanes of highway, as indicated by the "as constructed" plans, reveals 0.10 feet (3.0 cm) of traction sand are applied over the four lane surface on a mean annual basis between the top of Lookout Pass and Saltese, while 0.03 feet (0.9 cm) of traction sand are applied between Saltese and St. Regis.

Table K-2. Mean annual traction sand application rates along Interstate 90 between Lookout Pass and St. Regis, Montana

Mile Marker	Description	Percent Applied	Cubic Yards	Tons	Pounds per Square Foot	Depth (Feet)
0 to 10	Lookout Pass to Saltese	60	9,171	13,067	10.31	0.10
10 to 22	Saltese to Twelvemile Creek	20	3,057	4,356	2.88	0.03
22 to 34	Twelvemile Creek to St. Regis	20	3,057	4,356	2.88	0.03

Overall, 7.3 miles of Interstate 90 are within 100 feet of the St. Regis River, 12.0 miles are between 100 and 200 feet from the stream channel, 6.0 miles are between 200 and 300 feet of the stream channel and 9.8 miles are farther than 300 feet from the stream channel. In addition, the 7.3 miles of the interstate within 100 feet of the stream channel contain approximately 0.4 miles of bridge crossings. Thus, for this analysis, 6.9 miles of interstate are considered to be within 100 feet of the stream channel and 0.4 miles are made up of bridge crossings. Out of 6.9 miles of interstate within 100 feet of the stream channel, 3.0 miles of the eastbound lane are between 50 and 100 feet of the stream channel, and 2.5 miles are between 25 and 50 feet of the stream channel (**Table K-3**). Along the westbound lane 0.4 miles are between 50 and 100 feet of the stream channel, 0.5 miles are between 25 to 50 feet of the stream channel, and 0.5 miles are within 25 feet of the stream channel.

Table K-3. Length of Interstate 90 within 100 feet of the St. Regis River

Distance to Stream Channel	Eastbound Lane (Miles)	Westbound Lane (Miles)
50 to 100 Feet	3.0	0.4
25 to 50 Feet	2.5	0.5
Within 25 Feet	0.0	0.5
Total	5.5	1.4

Fill Slope Measurements

The accumulation of traction sand on fill slopes was examined primarily upstream of Saltese. At 13 measured sites, the mean observed extent of traction sand was 33 feet, with a minimum of 25 feet and a maximum distance of 45 feet. Fill slopes averaged a 45% slope and ranged from less than 10% to greater than 60% slopes. The maximum depth of accumulated traction sand deposits was 0.66 feet (20 cm) and it was observed within the first 20 feet from the interstate shoulder. The maximum mean depth of 0.37 feet (11.2 cm) occurred 10 feet from the road shoulder (**Figure K-1**). Lower angled slopes tended to have shallower deposits and shorter dispersal distances, while steeper slopes tended to have deeper deposits and greater dispersal distances. Traction sand deposits on fill slopes downstream of Saltese also followed this pattern, decreasing toward St. Regis as the rate of application decreases.

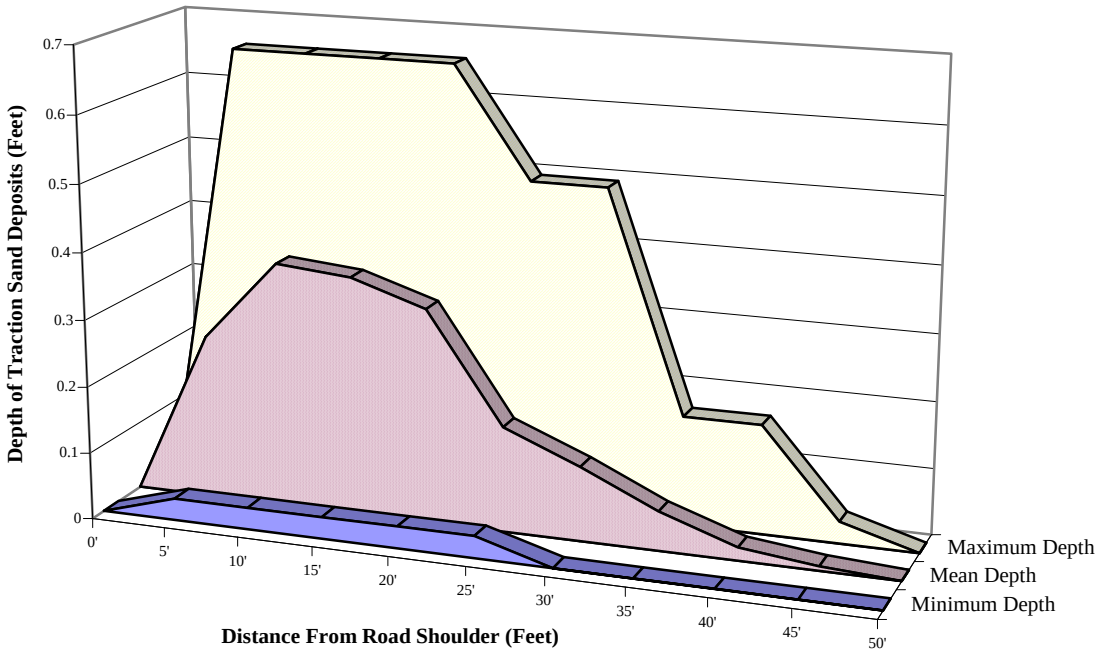

Figure K-1. Depth of traction sand on fill slopes measured at 5-foot intervals progressing away from the Interstate 90 shoulder

Eighty-eight percent of the mean traction sand deposit was found within the first 25 feet of the road shoulder, while only 12.0% of the mean deposit was found between 25 and 50 feet (**Table K-4**). Traction sand deposits started to taper off at approximately 20 feet from the road shoulder, with 78.4% of the traction sand deposit within 20 feet of the road shoulder. While no traction sand deposits were observed over 45 feet from the road shoulder at the 13 fill slope assessment sites, additional observations of traction sand movement made during the stream channel assessment indicate traction sand is dispersed as far as 112 feet from the road shoulder on steep (>60%) fill slopes.

Table K-4. Percent of mean traction sand deposit accumulated on fill slopes measured at 5-Foot intervals from the road shoulder

Distance From Road Shoulder (Feet)	Percent of Mean Deposit	Cumulative Percent of Mean Deposit
0-5	14.9	14.9
5-10	22.3	37.2
10-15	21.7	58.9
15-20	19.5	78.4
20-25	9.6	88.0
25-30	6.8	94.8
30-35	3.6	98.4
35-40	1.2	99.6
40-45	0.4	100
45-50	0	100

Culverts

Overall, 38 culverts were identified in the field. Thirty-two of these culverts provide potential pathways to the stream channel and 8 of these culverts discharge within 30 feet of the stream channel (**Table K-5**). Twenty-one out of 32 culverts providing pathways to the stream channel are associated with cut slopes. Four culverts were identified in Reach 9, though only one of them appears to provide a pathway for traction sand to enter the stream channel. Seven culverts were identified in Reach 8, 5 of which provide pathways to the stream channel, while one culvert discharges within 30 feet of the stream channel. Three cut slopes are drained by culverts in Reach 8. Twelve culverts were found in Reach 7, 11 of which lead to the stream channel, and 4 of which discharge within 30 feet of the stream channel. Three cut slopes are drained by culverts in Reach 7. Two culverts drain two cut slopes in Reach 6, while no culverts were identified in Reaches 4 and 5 with only one cut slope identified in each of these two reaches. Seven culverts providing pathways to the river were identified in Reach 3, all of which are associated with cut slopes. Five culverts were identified in Reach 2, all of which are associated with cut slopes, while Reach 1 contains only one culvert that drains a cut slope.

Table K-5. Culverts draining Interstate 90 with the potential to deliver traction sand into the St. Regis River

Reach	Culvert	Mile Marker	Drain Cut Slope?	Perennial?	Application Rate(Lbs/SqFt)	Associated with a Cut Slope?
9	1	2.18	No	No	11.05	
8	2	2.95	No	No	11.05	
8	3	3.2	No	No	11.05	
8	4	3.42	Yes	Yes	11.05	yes
8	5	5.2	Yes	Yes	11.05	yes
8	6	5.9	Yes	Yes	11.05	yes
7	7	7.04	Yes	Yes	11.05	yes
7	8	7.5	No	Yes	11.05	
7	9	7.7	No	Yes	11.05	
7	10	7.95	Yes	No	11.05	yes
7	11	8.02	No	Yes	11.05	
7	12	8.17	No	No	11.05	
7	13	8.4	No	No	11.05	
7	14	8.53	No	Yes	11.05	
7	15	8.65	Yes	No	11.05	yes
7	16	9.2	No	Yes	11.05	
7	17	9.85	No	No	11.05	
6	18	12.58	Yes	Yes	3.09	yes
6	19	13.17	Yes	No	3.09	yes
3	20	23.8	Yes	No	3.09	yes
3	21	23.83	Yes	No	3.09	yes
3	22	24.25	Yes	Yes	3.09	yes
3	23	24.35	Yes	Yes	3.09	yes
3	24	24.8	Yes	No	3.09	yes
3	25	24.95	Yes	Yes	3.09	yes
3	26	25.8	Yes	No	3.09	yes
2	27	26.5	Yes	No	3.09	yes
2	28	27.1	Yes	Yes	3.09	yes
2	29	27.45	Yes	Yes	3.09	yes
2	30	27.96	Yes	No	3.09	yes
2	31	28.58	Yes	No	3.09	yes
1	32	30.55	Yes	No	3.09	yes

Cut Slopes

Forty-seven cut slopes were identified along Interstate 90 between St. Regis and Lookout Pass covering a linear roadside distance of 9.7 miles (51,300 feet) and a total area of 180.0 acres (**Table K-6**). The majority of cut slopes are located along Reaches 2, 3, 6, and 7.

Table K-6. Cut slopes associated with Interstate 90 along the St. Regis River

Reach	# of Cut Slopes	Length (Miles)	% of Reach	Area (Acres)
1	2	0.6	13	5.9
2	10	2.6	73	48.0
3	11	2.0	41	32.0
4	1	0.1	2	4.0
5	1	0.2	5	1.6
6	7	1.9	41	48.7
7	8	1.2	27	23.9
8	3	0.4	13	3.3
9	4	0.7	19	12.6
Total	47	9.7	26	180.0

Erosion rates for cut slopes in which the parent geology is Precambrian Belt series metasedimentary rocks average 30 tons/acre/year (Washington Forest Practices Manual 1997). Field assessment of cut slope material indicated that cut slopes were only partially comprised (35%) of highly erodible materials such as sand and fine gravels. Thus, the erosion rate of 30 tons/acre/year was calculated for 35% of the cut slope area along Interstate 90. Overall, culverts potentially drain 105.5 acres of cut slope surface area. Reaches 1-6 contain 95.9 acres of cut slope associated with culverts leading to the stream channel, while Reaches 7-9 have only 9.5 acres of cut slope associated with culverts leading to the stream channel. However, only 56.9 acres of cut slope in Reaches 1-6 were determined to drain into culverts and 5.5 acres of cut slopes drain into culverts in Reaches 7-9. Best professional judgment was used to determine that 10% of the eroded material at the base of cut slopes was transported to the stream channel on an annual basis, though standard models suggest a higher delivery rate (Washington Forest Practices Manual 1997). Thus, a total of 66 tons are delivered to the St. Regis River annually from cut slopes with a delivery rate of 10% (**Table K-6**).

Input of Traction Sand from Interstate 90

The assessment of traction sand delivery into the St. Regis River was based on the following criteria:

1. Eastbound and westbound lanes were considered separately. Thus, the application rate of traction sand was considered over the linear length of road multiplied by width of 2 lanes of highway (24 feet). Reaches 1-6 have an application rate of 2.88 pounds per square foot, while Reaches 7-9 have an application rate of 10.03 pounds per square foot (**Table K-2**). Contribution rates were determined for only the two adjacent lanes. Thus, fill slope contribution based on the proximity of the road shoulder to the stream channel were determined for the two lanes abutting the stream channel, while the assessment of culvert drainage was also considered for only the pertinent two lanes. Along the St. Regis River, fill slopes were generally found along the eastbound lane and culvert inlets were generally found along the westbound lane.
2. Contribution from stretches of road greater than 100 feet from the stream channel was considered to be zero for the two lanes abutting the stream channel, though culvert contribution from the other two lanes were considered when appropriate. Thus, all the traction sand applied to stretches of road greater than 100 feet from the stream channel and not drained by culverts was considered to be stored.

Fill slope assessments indicate that sediment transport from Interstate 90 into the stream channel is most likely when the road is within 50 feet of the stream channel (**Figure K-1**). Thus, the major input of traction sand occurs along the 2.5 miles of eastbound Interstate 90 and the 1.0 miles of westbound Interstate 90 within 50 feet of the stream channel. Sections of interstate 90 within 50 feet of the stream channel tend to be associated with steep fill slopes that lack dense vegetative cover due to the annual application and accumulation of traction sand. In addition, the St. Regis River within these areas tends to be channelized with riprap, which limits the development of a buffer strip of riparian vegetation. While some fill slope storage clearly takes place, the transport of traction sand from fill slopes in areas where the interstate is within 50 feet of the stream channel appears to be considerable.

Eighty-eight percent of the traction sand applied is deposited within 25 feet of the road shoulder (**Figure K-1, Table K-4**). The only section of Interstate 90 within 25 feet of the stream channel is located along the westbound lane between mile markers 2.0 and 2.6. This section of Interstate 90 was determined in the field to be within an average of 15 feet of the stream channel. The 19.5% deposited between 15 and 20 feet, the 9.6% deposited between 20 and 25 feet, along with the 12.0% deposited between 25 and 50 feet yield a direct delivery rate of 41.1% (**Table K-4**). This analysis indicates the delivery of traction sand into the St. Regis River from sections of road within 25 feet of the stream channel averages 147.5 tons annually.

Figure K-1 and **Table K-4** indicate that sections of road between 25 and 50 feet from the stream channel directly receive between 0 and 12.0% of the traction sand applied. A delivery rate using the midpoint value of 6% of the total is used for sections of road between 25 and 50 feet of the stream channel. This analysis indicates delivery of traction sand into the St. Regis River from sections of road between 25 and 50 feet of the stream channel averages 88 tons annually.

Traction sand was not directly observed at distances greater than 50 feet in the fill slope assessment. However, stretches of interstate between 50 and 100 feet from the stream channel likely contribute some sediment. Traction sand was observed as far as 112 feet from the road shoulder during the stream channel assessment. Best professional judgment was used to determine that 3% of the traction sand applied between 50 and 100 feet of the stream channel is delivered on an annual basis. This delivery is likely comprised of the finest portion of the traction sand, such as particles that would pass though a #40 mesh (0 to 35% of the traction sand applied) and a # 200 mesh (0-10% of the traction sand applied). This analysis indicates delivery of traction sand into the St. Regis River from sections of road within 50 to 100 feet of the stream channel averages 22 tons annually.

The amount of road area delivering traction sand to culverts was determined for the lane abutting the culvert, which is generally the westbound lane along Interstate 90 between St. Regis and Lookout Pass. A contribution rate of 10% was determined using best professional judgment. This is the same rate employed in the delivery of cut slope erosion from the base of cut slopes, since many of these areas are overlapping. Drainage pathways leading to culverts occur on relatively low angled slopes that generally lack vegetation. Overall, 32 culverts drain 3.6 miles (18,800 feet) of interstate 90, leading to the input of 118 tons of traction sand into the St. Regis

River on an annual basis, with 66 tons delivered from Reaches 7-9 and 51 tons delivered from Reaches 1-6 (**Table K-5**).

There are no barriers to the movement of road sand from bridge decks into the stream channel. However, the Montana Department of Transportation reports that traction sand is removed from bridge decks (D. Moeller, MDT, pers. comm., 2003). A 90% delivery rate was selected to account for bridge deck clean up. There are a total of 14 Interstate 90 crossings of the St. Regis River totaling approximately 2,100 feet in length (0.4) miles. Bridge deck contributions were considered separately from sections of interstate within 25 feet of the stream channel. There were 3 crossings upstream of Saltese, where road sand application was greatest, while the remaining crossings were downstream of Saltese. A road width of 24 feet was assigned for single lane crossings, while 48 feet was used when both lanes crossed the river. Bankfull widths of the St. Regis River measured during TMDL development were used to determine the contributing length of road along delineated reaches. Thus, a bridge crossing near the mouth of the St. Regis River (Reach 1) was considered to have a contributing length of 176.8 feet based on bankfull channel measurements, while a bridge crossing in reach 9 was assigned a contributing length of 27.1 feet based on bankfull channel measurements. This assessment indicates that 91 tons are delivered from bridge decks annually.

The linear length of road capable of contributing traction sand into the stream channel was determined and the amount of traction sand delivered to the St, Regis River on an annual basis was estimated. Various sources were assigned the individual delivery rates described above. This analysis indicates that 486 tons of traction sand are delivered to the St. Regis River during an average winter, which amounts to roughly 2.1% of the annual application rate of 23,367 tons of traction sand (**Table K-7**). Sections of Interstate 90 within 100 feet of the stream channel contribute 277 tons annually, delivery of traction sand through culverts contributes 118 tons annually, and bridge decks contribute 91 tons annually. A detailed assessment of traction sand contributions is presented in **Table K-8**.

Table K-7. Mean annual input of traction sand into the St. Regis River from Interstate 90

Source	Tons	Percent of Mean Annual Application Rate
Interstate within 100 feet of the channel	258	1.12%
Contribution through culverts	118	0.5%
Contributions from bridges	91	0.4%
TOTAL	467	2.1%

Table K-8. Estimated traction sand delivery rates from contributing road segments

		Westbound Lane		Eastbound Lane	
		Reaches 1-6	Reaches 7-9	Reaches 1-6	Reaches 7-9
Traction sand application rate (lbs/sqft)	**Delivery Rate**	**3.091**	**11.048**	**3.091**	**11.048**
Length of road between 50 and 100 feet (feet)		1300	600	15000	1000
Surface area (sqft)		31200	14400	360000	24000
Traction sand delivery (pounds)	0.03	2700	4455	31158	7424
Traction sand delivery (tons)		1.4	2.2	15.6	3.7
Length of road between 25 and 50 feet (feet)		2600	0	3100	10200
Surface area		62400	0	74400	244800
Traction sand delivery (pounds)	0.06	10801	0	12879	151458
Traction sand delivery (tons)		5.4	0.0	6.4	75.7
Length of road within 25 feet (feet)		0	2900	0	0
Surface area		0	69600	0	0
Traction sand delivery (pounds)	0.41	0	294253	0	0
Traction sand delivery (tons)		0.0	147.1	0.0	0.0
TOTALS					
Traction sand delivery (pounds)		14465	320807	47178	170227
Traction sand delivery (tons)		6.8	149.4	22.0	79.4
Bridges				0	0
Surface area (based on # of lanes and bfw)		48,062	4,819	0	0
Traction sand delivery (pounds)	0.9	133,695	47,916	0	0
Traction sand delivery (tons)		66.8	24	0	0

The majority of the traction sand entering the stream channel is derived from two stretches of Interstate 90. Traction sand inputs within 25 feet of the stream channel for 2,900 feet (approximately 0.5 miles) from mile marker 2.0 to 2.6 along the westbound lane accounts for 158 tons, which is 33% of the mean annual delivery rate (**Table K-9**). A 10,200 foot (1.9 mile) stretch of road just upstream of Saltese, in which the interstate is within 50 feet of the stream channel from mile marker 8.0 to mile marker 10.0, contributes 81 tons, which accounts for approximately 17% of the mean annual delivery rate. Thus, direct runoff from Interstate 90 along these two stretches of highway accounts for almost 50% of the total contribution of traction sand, while the other stretches of Intestate 90 within 100 feet of the stream channel account for 38 tons, which is approximately 8% of the mean annual delivery rate. The remaining traction sand is contributed is through culverts (24%) and from bridges decks (19%).

Table K-9. Percent contribution of traction sand to the St. Regis River from Interstate 90

Source	Tons	Percent
Mile markers 2.0-2.6 and 8.0-10.0	223	49%
Other portions of I-90 within 100 feet of the channel	35	7%
Contribution through culverts	118	25%
Contribution from bridges	91	19%

Additional Sites of Concern

There are two sites in Reach 9 in which traction sand drainage may impact the St. Regis River. Erosion from the eastbound lane along the base of a cut slope leads into a ditch and drains approximately 1,000 feet of road surface and empties into the forest at approximately mile marker 2.8 creating a large sediment plume extending into the forest. While this sediment plume does not reach the stream channel, it certainly has an environmental impact within the forest and over time may extend to the stream channel. A drainage ditch along the westbound lane also drains approximately 500 feet of roadway into a ditch at approximately mile marker 2.8 and may discharge in to the stream channel. In addition, a culvert at mile marker 7.7 is almost completely blocking the drainage of a perennial stream, which has led to a channel being formed along the base of the cut slope that leads to the next culvert at mile marker 7.8.

Stream Crossings

A total of approximately 108 stream crossing were identified on private lands in the St. Regis watershed using GIS. Sixteen stream crossings were assessed in the field on Little Joe, Twelvemile, Savenac, Big, Twin, and Packer creeks using a modified Washington Field Assessment Method. Approximately 2.6 tons of sediment are delivered to St. Regis River tributaries on an annual basis from these sixteen stream crossings. This averages 0.16 tons (320 pounds) from each stream crossing annually. Based on the average load per stream crossing, the estimated annual sediment load is 17.3 tons for all 108 stream crossings (**Table K-10**). This assessment was followed up by further monitoring using WEPP Road monitoring and modeling methods that are presented in **Appendix I**. The WEPP modeling results are used for source assessment and allocation. The information provided in this stream crossing section is provided to support that the WEPP Road modeling results are in the same range as this alternative method.

Table K-10. Sediment Contributions from Stream Crossings on Private Lands in the St. Regis Watershed

Sub-watershed	Number of Crossings Assessed	Total Crossings on Private Land	Annual Sediment Contribution (Tons)
Upper St. Regis	0	4	0.6
Packer	4	7	1.1
Silver-Timber	0	14	2.2
Big	3	3	0.5
Savenac	2	6	1.0
Twin	2	23	3.7
Deer	0	1	0.2
Twelvemile	4	20	3.2
Ward	0	0	0.0
Twomile	0	5	0.8
Little Joe	1	3	0.5
Lower St. Regis	0	22	3.5
TOTAL	**16**	**108**	**17.3**

Literature Cited

Washington Forest Practices Board. 1997. Standard Methodology for Conducting Watershed Analysis.